[CHAUTAUQUAN.]

What is Chemistry?

Everybody who thinks must be impressed by the great variety of things found on this earth, and the question, What does the earth consist of? must often suggest itself. Among the important results reached in studying the things around us is this, that notwithstanding their great variety they are made of simple things, and these in turn of still simpler—that there are, in fact, only about seventy distinct kinds of matter, and that all the complex things around us are made up of these seventy elements. The solid crust of the earth, as far as it has been possible to investigate it, all living things, both animals and plants, the air and water, consist essentially of twelve elements. The elements do not, as a rule, occur as elements. They are generally found in combination with one another. Oxygen and nitrogen are, to be sure, found in the air as elements, uncombined; but such familiar substances as water, salt, and quartz consist of elements in combination. Thus water consists of hydrogen and oxygen. Hydrogen, the element, is a colorless, tasteless, inodorous, and very light gas that burns readily. Oxygen, the element, is also a colorless, tasteless, inodorous gas. It does not burn, but burning things burn with much increased brilliancy in it. When hydrogen and oxygen are mixed together in a vessel under ordinary conditions, no action takes place. They mix thoroughly, forming a mixture that is also a colorless, tasteless, inodorous gas. If a spark is applied to this mixture, a violent explosion occurs, and this is the signal of a great change. The two gases have entered into chemical combination; they are no longer the gases hydrogen and oxygen; they have entered into combination and now form the liquid water, a substance with properties entirely different from those possessed by the constituents.

Again, chlorine, the element, is a greenish-yellow gas that acts violently upon other things and causes changes in them. Inhaled even in small quantity it gives rise to distressing symptoms, and in larger quantity it causes death. Its odor is extremely disagreeable. Sodium, the element, is an active substance that has the power to decompose water and set hydrogen free. When chlorine gas is brought together with sodium, the two combine chemically and form the well known compound salt, or, as the chemist calls it, sodium chloride. From this the elements chlorine and sodium can be obtained by the chemist. These two examples serve to show what is meant by chemical combination and by a chemical compound. Chemical compounds are generally found mixed with other compounds. This is shown, for example, in many of the varieties of rocks, as granite, which consists of three different chemical compounds. It is shown much more strikingly in living things, all of which are made up of a large number of chemical compounds, mixed, to be sure, not in a haphazard way, but beautifully adjusted and working together in wonderful harmony. Just as elements combine chemically to form compounds, so elements act upon compounds and cause changes in their composition. Thus, oxygen is constantly acting upon other things, sometimes slowly, but, in the case of fire, rapidly and with tremendous energy. It is commonly said that fire destroys things. In fact, it changes their composition, and the principal products of the change are gases. This kind of chemical change is the most familiar that is brought about by the action of an element upon compounds. Compounds, too, act upon compounds, and cause an infinite number of changes in composition. Thus the food we partake of consists of chemical compounds. In the body these compounds find others and they act upon one another so as to repair the wasted tissues and cause growth. The gas known as carbonic acid, that is contained in the air, acts upon the compounds in the leaves of plants and causes changes that are absolutely essential to the life and growth of the plant.

Look, then, in any direction and you will see evidence of changes in composition that are constantly taking place, and that are essential to the existence of the world as it is. These changes in composition and the compounds themselves that are involved in the changes form the subject of chemistry. In the light of what has been said it is clear that chemistry must be a very broad science. Remembering that chemical action is the cause of the formation of chemical compounds, that without chemical action the compounds would cease to exist and would be resolved into their elements, it is impressive to think what would take place if chemical action should cease. Most of the things familiar to us could not exist. The solid portions of the earth would, to a large extent, be replaced by the element silicon, something like charcoal, and by oxygen and a few metals such as sodium, potassium, and aluminum. Water would be resolved into the two gases hydrogen and oxygen. All living things would fall to pieces, and in their place we should have the gases, hydrogen, oxygen, and nitrogen, and the solid element carbon, most familiar to us in the form of charcoal. Life would, therefore, be impossible.

New Cave Discoveries at Mentone.

The first discovery of a skeleton and some other remains at Mentone, France, was made in 1872.

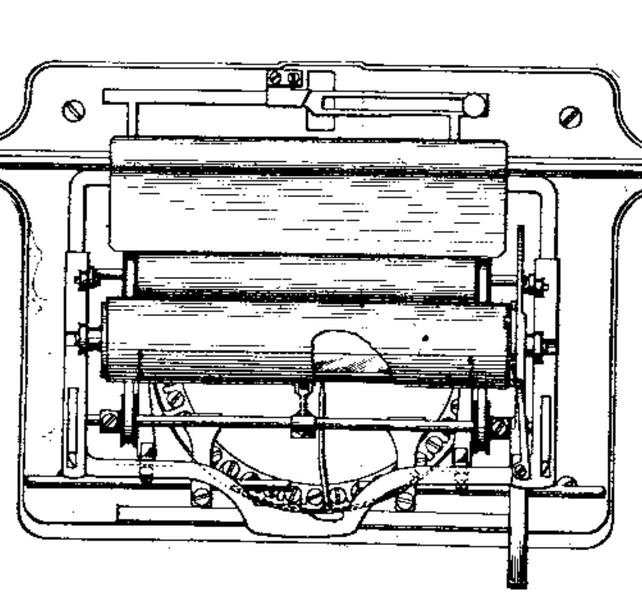
In January last another skeleton was found. It is that of a man almost six and a half feet tall; it was lying on the back with the left hand under the head. Around it were bones of animals, perforated shells and stag's teeth. Near by were a very sharp unused flint knife and a crystal of carbonate of lime. In the neighborhood vertebræ of the mammoth and what appears to be a paleolithic stone implement were found.—*Globus.*

A DEVICE ENABLING THE TYPEWRITER TO SEE AND READ WORK AS IT IS WRITTEN.

One of the annoying features of several of the most deservedly popular of the typewriting machines is the fact that the carriage has frequently to be lifted, that the operator may examine the work as it progresses. The necessity for this is obviated by a simple device recently introduced and styled the "Typewriter Prism," a rod of polished cut glass fastened to the carriage beneath the impression roller. Two of its sides are flat and inclined to each other at an angle of 45 degrees, and the third side is a strong cylindrical curve, perfectly reflecting the writing and presenting it right side up and in normal position to the eye of the operator.

The accompanying engraving illustrates the application of the improvement to the Smith-Premier machine, the position of the prism being shown by dotted lines on and in a broken-away portion of the impression roller. The prism can also be adjusted with best results to the Remington, Caligraph and Yost machines.

The prism in no way interferes with the operation of the machine, and when a letter has been omitted or a wrong letter struck, the carriage can be instantly moved to the desired point and the correction made without lifting the carriage to locate the error, while it is the only device yet invented enabling the operator to tabulate conveniently. The prism has been in use in the office of the SCIENTIFIC AMERICAN for some time and has given much satisfaction. A great many operators are using this improvement, of which Mr. Birket Clarke, 106 Fulton Street, New York, is the general agent.



TYPEWRITER PRISM APPLIED TO SMITH-PREMIER MACHINE.

Liquids and Gases.

It requires some effort of imagination to think of a gas so compressed as to have a density nearly equal to the density of water, and to possess the consistence of tar or of honey; very slightly compressible, like a liquid, and nevertheless a gas. So we need not wonder that even physicists, who at times are bold enough in their hypotheses, were rather slow in accepting a conception so widely different from our daily experience of liquids and gases. Such a state of matter is, however, known; it has been observed in our laboratories, and its existence was indicated as early as 1822, by Cagniard-Latour, and later on by Faraday. But it was only in the seventies, after two such bright minds as the Belfast professor, Andrews, and the Russian professor, Mendeleeff, came—the one through experiment and the other theoretically—to recognize its reality and significance, that scientists came round to the view that matter may exist in a state intermediate between its liquid and gaseous states. The idea is now generally accepted, and during the last five and twenty years immense researches have been made upon or in connection with this subject. Andrews made his discovery while liquefying carbonic acid gas. Unlike oxygen or nitrogen, which both require very low temperatures for being brought into their liquid state, carbon dioxide liquefies very easily. At the temperature of the freezing point it is sufficient to exert upon it a pressure thirty-six times greater than the pressure of our atmosphere to have it as a liquid, the density of which is four-fifths of the density of water. If its temperature be raised to 59° Fahrenheit, a pressure of 52 atmospheres is again sufficient to overcome the tendency of its molecules toward scattering in space; it becomes a liquid.

But when Andrews took the same gas at a temperature of 96°, he could exert upon it a pressure of 108 atmospheres and more without seeing any traces of liquefaction. Under this pressure the gas was reduced to $\frac{1}{480}$ part of the volume it occupied at the freezing point; its density was equal to the density of liquid carbonic acid, and yet it was not a liquid, although, like a liquid, it yielded but little to a further increase of pressure. However, as soon as its temperature was brought below 88°—the pressure remaining the same—the gas was found to be in a liquid state, without any alteration of its volume, or any sudden evolution of heat, having taken place. A temperature of 88° is thus its critical point. Below that limit its liquefaction is easy; above it, it is impossible. Further experiments convinced Andrews that other gases behave in the same way at their own critical temperatures, and he at once understood the philosophical bearing of his observations. There is, he wrote, a close and intimate connection between the ordinary gaseous and the ordinary liquid state of matter. The two are but widely separated forms of the same condition, and they may be made to pass into one another by a series of gradations so gentle that the passage shall nowhere present a breach of continuity. From carbonic acid as a perfect gas to carbonic acid as a perfect liquid the transition may be accomplished by a continuous process. But if any one ask whether the carbonic acid, taken at a temperature above its critical point, be in its gaseous or liquid state, the question does not admit of a positive reply. It stands "nearly midway between the two, and we have no valid ground to assign the one or the other." As to the explanation of this state, it must be sought for in the cohesion between the molecules; and further research, he added, will probably disclose the continuity of the liquid and solid states as well.

Andrews came to his discovery by starting from the gaseous state of matter; Mendeleeff came to the same discovery by starting from the liquid state. All liquids, he wrote in 1861, have a certain cohesion between their particles; this is what distinguishes them from gases; but the heating of a liquid steadily diminishes its cohesion, and consequently there must be for each liquid a certain temperature (the absolute boiling point) at which cohesion between its particles must entirely vanish, so that at and above that temperature it cannot exist as a liquid. It must then form a gas, and so long as it has not been cooled below the above limit, no amount of pressure will be able to restore it to its liquid state. Thus, starting from the two opposite ends of the scale, Andrews and Mendeleeff came to identical conclusions. Deduction and induction had joined hands. It is now known that their generalization was correct. All physical bodies have their critical temperatures or absolute boiling points, above which they cannot exist as liquids, whatever pressure they might be submitted to. For water this critical point is 689° of the Fahrenheit scale; for ether it is 383° or 386°; but for several gases it lies so deep that in order to liquefy them one must approach the absolute zero (459° below the freezing point), at which no thermic vibrations exist and even chemical affinity disappears unless stimulated by electricity. Thus, oxygen must be cooled down to 299° below the Fahrenheit zero, and nitrogen to —315° in order to be liquefied; while the critical temperature of hydrogen must be still lower—somewhere about 360° of cold. This is why Professor Dewar, who liquefies air in an open tube—that is, at the ordinary atmospheric pressure—could not yet liquefy hydrogen in the same way; and Amagat saw this gas at the ordinary temperature of our rooms remaining a gas, even under a pressure of 2,800 atmospheres, when it was squeezed within one-thousandth part of its previous volume.—*Prince Kropotkin, Nineteenth Century.*

Opening of the Exhibition at Lyons, France.

The great Exhibition of Arts, Sciences, and Industries was opened at Lyons April 29. A throng of conspicuous men attended the ceremonies. The whole Cabinet was present, but the President was unable to come. The exhibition, although formally opened, is far from ready for the public. The interior of the main building is still in the hands of the carpenters and the decorators. The main building covers 5,000 square yards, and is surmounted with a fine cupola. There are large pavilions for exhibits of viticulture and agriculture, greenhouses, and buildings for the fine arts.